July 1971

Brief 71-10215

NASA TECH BRIEF

Lewis Research Center

Digital Computer Program for Analyzing Chugging Instabilities

The problem:

To devise a means for analyzing chugging, a common problem encountered in the development of liquid propellant rocket engines. Chugging is a low frequency instability caused by a coupling of the propellant feed system with the combustion dynamics in such a way as to reinforce any disturbance in pressure or propellant flow.

The solution:

A digital computer program designed to analyze chugging instabilities and generate stability limits for a bipropellant rocket engine. The program computes combustion delays, gas residence time, characteristic velocity, and other steady-state parameters required for the solution of the characteristic equation. The characteristic equation is solved for critical values of the injector pressure drops and the chugging frequency.

How it's done:

A double-dead-time model, which requires the application of the respective time delay to each propellant and results in significantly different stability characteristics, was used in the analysis. Experimental data have been matched using this model.

Linearized feed-system impedances are evaluated at each frequency of interest. In addition to chamber and injector flow dynamics, the program can handle combinations of pumps, valves, manifolds, and lines. For any selected engine configuration, the program computes the required steady-state engine parameters for the solution of the characteristic equation. Available vaporization and drop-size correlations are used to calculate combustion time delays.

Stability limits were generated for a specific flox-methane engine system. An expander cycle with a turbine-bypass throttle was assumed. Results were obtained for two candidate injector types. For each injector configuration, the limits for throttling at a constant mixture ratio and the effects that varying the fuel injection area had on stability were determined.

Notes:

1. This program is written in FORTRAN IV for use on the IBM-7094 computer.
2. Requests for further information may be directed to:

   COSMIC
   Barrow Hall
   University of Georgia
   Athens, Georgia 30601
   Reference: B71-10215

Patent status:

No patent action is contemplated by NASA.

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